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Data amplifier and laser supply circuit for CD player and read only optical systems

TDA1302T

FEATURES

- Six input buffer amplifiers with low-pass filtering and with virtually no offset
- HF data amplifier with a high or low gain mode
- Two built-in equalizers for single or double-speed mode ensuring high performance in both modes
- Fully automatic laser control including stabilization and an ON/OFF switch, plus a separate supply (V_{DDL}) for power reduction
- Adjustable laser bandwidth and laser switch-on current slope
- Protection circuit to prevent laser damage due to supply voltage dip
- Optimized interconnectiion between pick-up detector and digital servo processor (TDA1301T)
- Wide supply voltage range
- Wide temperature range
- Low power consumption.

GENERAL DESCRIPTION

The TDA1302T is a data amplifier and laser supply circuit for three-beam pick-up detectors applied in a wide range of mechanisms for Compact Disc and read only optical systems. The device contains 6 amplifiers which amplify and filter the focus and radial diode signals and provides an equalized RF signal suitable for single or double speed mode; the mode can be switched by means of the speed control pin. The device can accommodate astigmatic, single foucault and double foucault detectors and can be applied to all N-sub laser/monitor diode units even though the circuit has been optimized for the Philips CDM12 mechanisms and the digital servo controller TDA1301T. After a single initial adjustment the circuit will maintain control over the laser diode current thus resulting in a constant light output power which is independent of ageing. The IC is mounted in a small-outline package to enable it to be mounted close to the laser pick-up unit on the sledge.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{DD}	supply voltage (pin 18)		3.4	–	5.5	V
Diode current amplifiers						
G_{dn}	amplification		–	1.55	–	dB
$I_{os(d)}$	diode output offset current		–	–	100	nA
B	3 dB bandwidth	$I_{i(d)}$ = 1.67 µA	50	–	–	kHz
RFE amplifier (built-in equalizer)						
$t_{d(eq)}$	equalization delay	f_i = 0.3 MHz	–	320	–	ns
$t_{d(f)}$	flatness delay	double-speed	–	5	–	ns
Laser supply						
$I_{o(l)}$	output current	V_{DDL} = 3 V	–	–	–100	mA

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA1302T	SO24	plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1

SCHEMATIC DIAGRAM

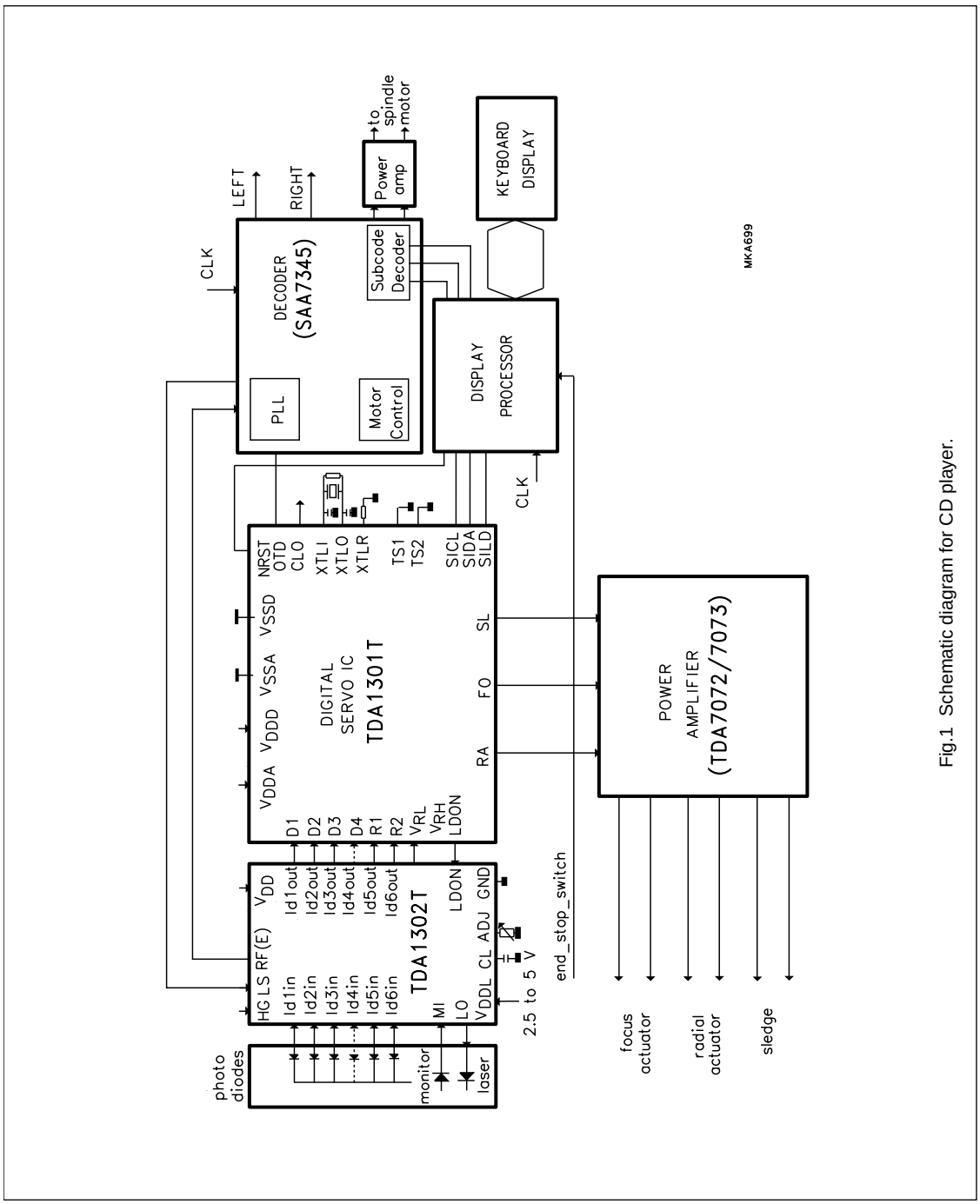

Fig.1 Schematic diagram for CD player.

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BLOCK DIAGRAM

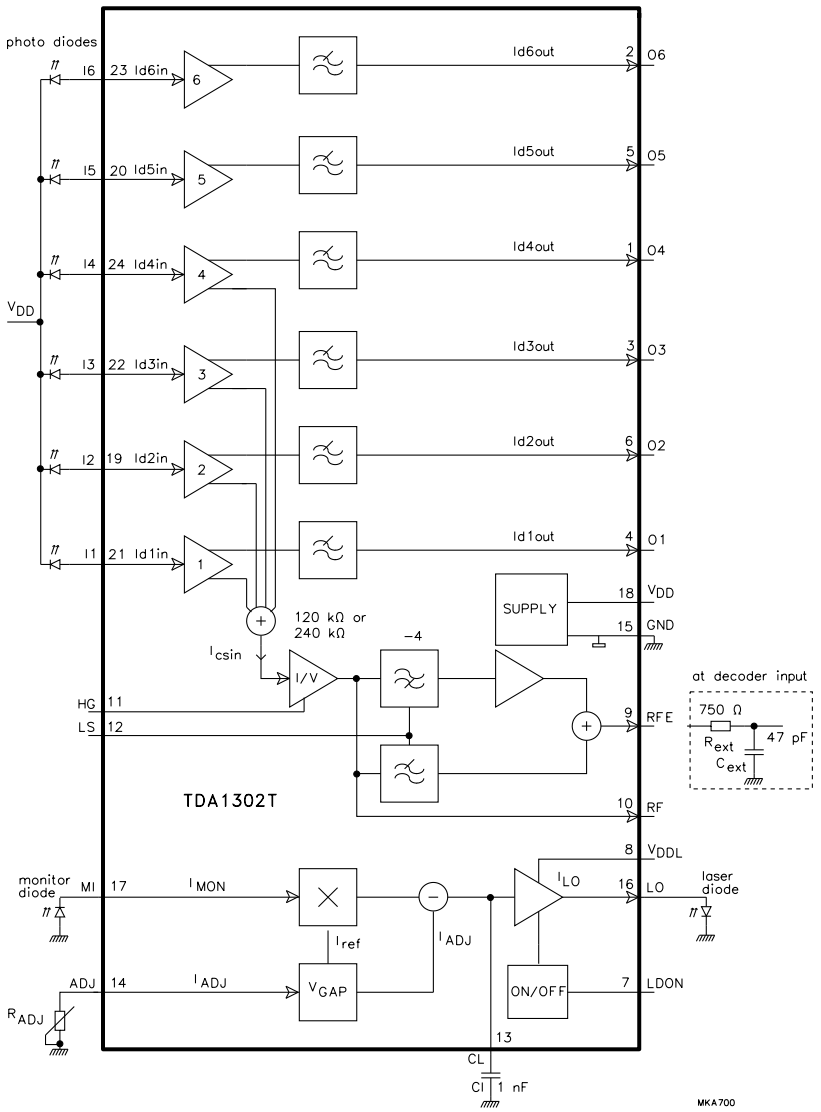

Fig.2 Block diagram.

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PINNING

SYMBOL	PIN	DESCRIPTION
O4	1	output of diode current amplifier 4
O6	2	output of diode current amplifier 6
O3	3	output of diode current amplifier 3
O1	4	output of diode current amplifier 1
O5	5	output of diode current amplifier 5
O2	6	output of diode current amplifier 2
LDON	7	control pin for switching the laser ON and OFF
V_{DDL}	8	laser supply voltage
RFE	9	equalized output voltage of sum signal of amplifiers 1 to 4
RF	10	unequalized output
HG	11	control pin for gain switch
LS	12	control pin for speed switch
CL	13	external capacitor
ADJ	14	reference input normally connected to ground via a resistor
GND	15	0 V supply; substrate connection (ground)
LO	16	current output to the laser diode
MI	17	laser monitor diode input
V_{DD}	18	amplifier supply voltage
I2	19	photo detector input 2 (central)
I5	20	photo detector input 5 (satellite)
I1	21	photo detector input 1 (central)
I3	22	photo detector input 3 (central)
I6	23	photo detector input 6 (satellite)
I4	24	photo detector input 4 (central)

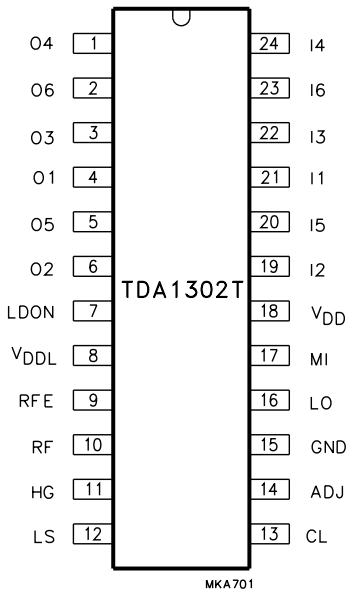

Fig.3 Pin configuration.

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FUNCTIONAL DESCRIPTION

The TDA1302T can be divided into two main sections, the laser control circuit and the photo diode signal filter and amplification section.

Laser control circuit

The main function of the laser control circuit is to control the laser diode current in order to achieve a constant light output power which is based on the current of the monitor diode which is continuously monitored. The circuit is built up into three parts.

The first part is the input stage which compares the monitor diode current with a current which is 10 times the value of the adjustable current. The adjustable current is derived from a bandgap reference source, to be temperature independent, and can be further adjusted by the external resistor R_{ADJ} in order to adapt the circuit to the parameters of the laser/monitor diode unit to be used. The difference is fed to the second part.

The second part is the integrator stage which makes use of an external capacitor CL. This capacitor has two different functions.

During switch-on of the laser current, it provides a current slope of typically: $dI_{LO}/dt \cong 10^{-6}/CL$ (A/s).

After switch-on it ensures that the bandwidth conforms to the typical formula: $f_B \cong K \times A_{ext} \times 90^{-9}/(CL \times I_{MON})$ (Hz).

where A_{ext} represents the AC gain of an extra loop amplifier, if applied, and $K = dI_{monitor}/dI_{laser}$ which is determined by the laser/monitor unit.

I_{MON} is the average current (pin 17) at typical light emission power of the laser diode.

The third part is the power output stage, its input being the integrator output signal. This stage has a separate supply voltage (V_{DDL}) thereby offering the possibility of reduced power consumption by supplying this pin with the minimum voltage necessary.

It also has a laser diode protection circuit which is enabled prior to the output drive transistor becoming saturated due to a large voltage dip on V_{DDL}. Saturation will result in a lower current from the laser diode, which is normally followed immediately by an increment of the voltage from the external capacitor CL, which could cause damage to the laser diode at the end of the voltage dip. The protection circuit prevents an increment of the capacitor voltage and thus offers full protection to the laser diode under these circumstances.

Photo diode signal filter and amplification section

This section has 6 identical current amplifiers. Amplifiers 1 to 4 are designed to amplify the focus photo diode signals. Each amplifier has two outputs, an LF output and an internal RF output. Amplifiers 5 and 6 are used for the radial photo diode currents and have only an LF output. All 6 output signals are low-pass filtered with a corner frequency at 65 kHz. The internal RF output signals are summed together and converted into a voltage by means of a selectable transresistance of 120 kΩ or 240 kΩ. This signal is available directly at pin 10, however, there is also an unfiltered signal available at pin 9. The equalization filter used has 2 different filter curves, one for single-speed mode and one for double-speed mode.

Table 1 Operational modes.

SWITCH	PIN	IF NOT CONNECTED DEFAULT	MODE(1)					
			GAIN		SPEED		LASER	
			HIGH	LOW	SINGLE	DOUBLE	ON	OFF
Control pin	HG	1	1	0	X	X	X	X
	LS	1	X	X	1	0	X	X
	LDON	1	X	X	X	X	1	0

Note

1. Where X = don't care.

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LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{DD}	supply voltage	–	8.0	V
P_{tot}	total power dissipation	–	300	mW
T_{stg}	storage temperature	–65	+150	°C
T_{amb}	operating ambient temperature	–40	+85	°C

HANDLING

Classification A: human body model; C = 100 pF; R = 1500 Ω; V = ± 2000 V.
Charge device model: C = 200 pF; L = 2.5 μH; R = 0 Ω; V = 250 V.

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j\text{-}a}$	from junction to ambient in free air	60 K/W

QUALITY SPECIFICATION

In accordance with *"SNW-FQ-611 part E"*. The numbers of the quality specification can be found in the *"Quality Reference Handbook"*. The handbook can be ordered using the code 9398 510 63011.

CHARACTERISTICS

V_{DD} = 3.4 V; V_{DDL} = 2.5 V; T_{amb} = 25 °C; R_{ADJ} = 48 kΩ; HG = logic 1; LS = logic 1; with an external LP filter (R_{ext} = 750 Ω, C_{ext} = 47 pF) at pin 9; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
I_{DD}	amplifier supply current	laser OFF	–	8	–	mA
V_{DD}	amplifier supply voltage		3.4	–	5.5	V
V_{DDL}	laser control supply voltage		2.5	–	5.5	V
P_{diss}	power dissipation	laser OFF; V_{DD} = 3.4 V	–	27	–	mW
Diode current amplifiers (1 to 6)						
$I_{i(d)}$	diode input current	note 1	–	–	10	μA
N_{eq}	equivalent noise input		–	1	–	pA/√Hz
$V_{i(d)}$	diode input voltage	$I_{i(d)}$ = 1.67 μA	–	0.9	–	V
$V_{o(d)}$	diode output voltage		–0.2	–	V_{DD} – 1	V
G_{dn}	amplification	$I_{i(d)}$ = 1.67 μA; $V_{o(dn)}$ = 0 V; note 2	1.43	1.55	1.67	dB
$I_{os(d)}$	diode output offset current	I_{csin} = I_{tsin} = 0; note 3	–	–	100	nA
$Z_{o(d)}$	output impedance	I_{di} = 1.67 μA; $V_{o(dn)}$ = 0 V	500	–	–	kΩ
B	3 dB bandwidth	$I_{i(d)}$ = 1.67 μA	50	68	–	kHz
G_{mm}	mismatch in amplification	I_{di} = 1.67 μA; $V_{o(dn)}$ = $V_{o(dm)}$	–	–	3	%

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Data amplifier; equalized single and double speed						
V_{RFO}	DC output voltage	I_{csin} = 0	–	0.3	–	V
R_{RF}	transresistance	f_i = 100 kHz; note 4	100	120	143	kΩ
		f_i = 100 kHz; note 5	200	240	285	kΩ
V_{RFMO}	output voltage	note 6	–	–	V_{DD} – 1.2	V
SR_{RF}	slew rate	V_{SR} = 1 V (p-p)	–	6	–	V/μs
Z_{oRF}	output impedance	f_i = 1 MHz	–	100	–	Ω
$t_{d(eq)}$	equalization delay	note 7	–	320	–	ns
$t_{d(f)}$	flatness delay (Φ/ω)	LS = 1 or 0; notes 7 and 8	–	10.5	–	ns
G_R	gain ratio	note 8	4.5	6	–	dB
B_{RF}	unequalized output bandwidth	$I_{i(d)}$ = 1.67 μA	3	5	–	MHz
Control pins LDON, LS and HG (with 47 kΩ internal pull-up resistor)						
V_{IL}	LOW level input voltage		–0.2	–	+0.5	V
V_{IH}	HIGH level input voltage		V_{DD} – 1	–	V_{DD} + 0.2	V
I_{IL}	LOW level input current		–	–	100	μA
Laser output						
$V_{o(l)}$	output voltage	$I_{o(l)}$ = 100 mA	–0.2	–	V_{DD} – 0.7	V
$I_{o(l)}$	output current		–	–	–100	mA
Monitor diode input						
$V_{i(mon)}$	monitor input voltage	$I_{i(mon)}$ = –1 mA	–	V_{DD} – 0.7	–	V
$I_{i(mon)}$	monitor input current		–	–	2	mA
Reference source V_{GAP} and laser adjustment current I_{ADJ}						
V_{ref}	reference voltage	R_{ADJ} = 48 kΩ	1.15	1.24	1.31	V
ΔT	reference temperature drift	R_{ADJ} = 48 kΩ	–	40×10^{-6}	–	
SR_{ref}	reference supply rejection		–	–	1	%
I_{ADJ}	adjustment current	R_{ADJ} = 5.6 kΩ	–	–	200	μA
Z_i	input impedance	R_{ADJ} = 48 kΩ	–	1	–	kΩ
$d_{Io(l)}/dt$	slew rate output current	C_L = 1 nF	–	1	–	mA/μs
M	multiplying factor ($I_{i(mon)}/I_{ADJ}$)		–	10	–	

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Notes to the characteristics

1. The maximum input current is defined as the current in which the gain reaches its minimum. Increasing the supply voltage to V_{DD} = 5 V increases the maximum input current (see also Figs 4 and 5).
2. The gain increases if a larger supply voltage is used (see also Fig.6).
3. I_{csin} is the sum of the diode input currents 1 to 4; I_{tsin} is the sum of the diode input currents 5 and 6.
4. Transresistance 120 kΩ means LOW gain, selected if HG = logic 0 (see Table 1).
5. Transresistance 240 kΩ means HIGH gain, selected if HG = logic 1 (see Table 1).
6. Output voltage swing will be: $V_{SRRF} = V_{RFMO} = V_{RFO(p-p)}$.
7. Refers to equalized output only.
8. For single speed the gain ratio is defined as gain difference between 1 MHz and 100 kHz, while the flatness delay is defined up to 1 MHz (see also Fig.7). For double speed the gain ratio is defined as gain difference between 2 MHz and 200 kHz, while the flatness delay is defined up to 2 MHz.

Transfer function

The equalized amplifier including C_{ext} and R_{ext} has the following transfer functions, where ‘rfe’ refers to equalized output only and ‘rf’ refers to equalized and not equalized outputs.

FOR SINGLE SPEED (SP = LOGIC 1)

$$\frac{V_{rfe}}{I_{csin}} = R_{rf} \times \frac{\left(1 - ks^2\right)/\omega^2_{os}}{1 + 1/Q \times s/\omega_{os} + s^2/\omega^2_{os}} \times \frac{1}{1 + s/\omega_1} \times \frac{1}{1 + sR_{ext} \times C_{ext}} \quad (1)$$

FOR DOUBLE SPEED (SP = LOGIC 0)

$$\frac{V_{rfe}}{I_{csin}} = R_{rf} \times \frac{\left(1 - ks^2\right)/\omega^2_{os}}{1 + 1/Q \times s/\omega_{od} + s^2/\omega^2_{od}} \times \frac{1}{1 + sR_{ext} \times C_{ext}} \quad (2)$$

The denominator forms the denominator of a Bessel low-pass filter.

Table 2 Transresistance.

SYMBOL	DESCRIPTION	TYP.	UNIT
k	internally defined	4	
$\omega_{os}/\omega_1 = \omega_{od}/\omega_2$	internally defined	1.094	
Q	internally defined	0.691	
$\omega_{od} = 2 \times \omega_{os}$	internally defined	17.6×10^{-6}	rad/s
R_{RF}	see Chapter “Characteristics”	–	
R_{ext}	external resistor	750	Ω
C_{ext}	external capacitor	47	pF

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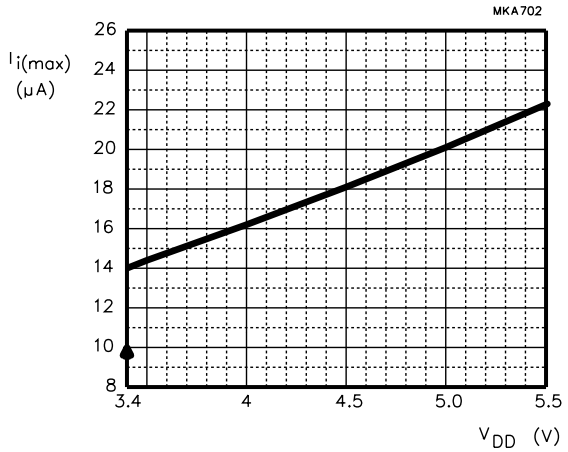
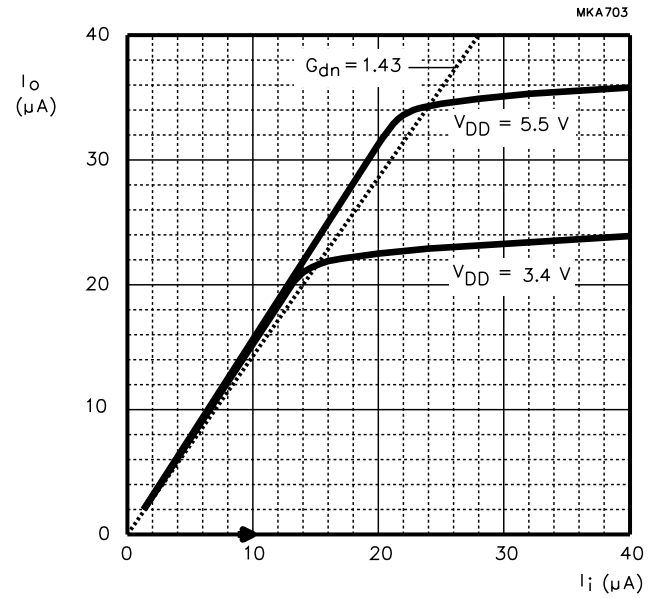


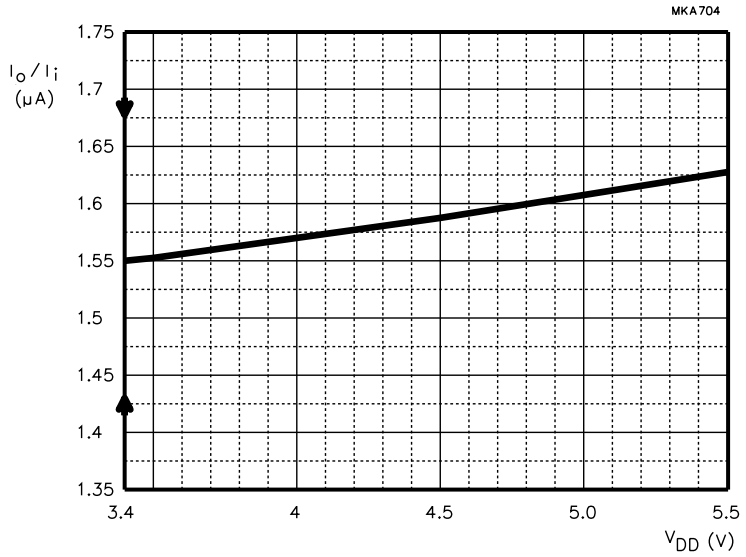
↑ = test limit.

Fig.4 Maximum input current as a function of V_{DD}.



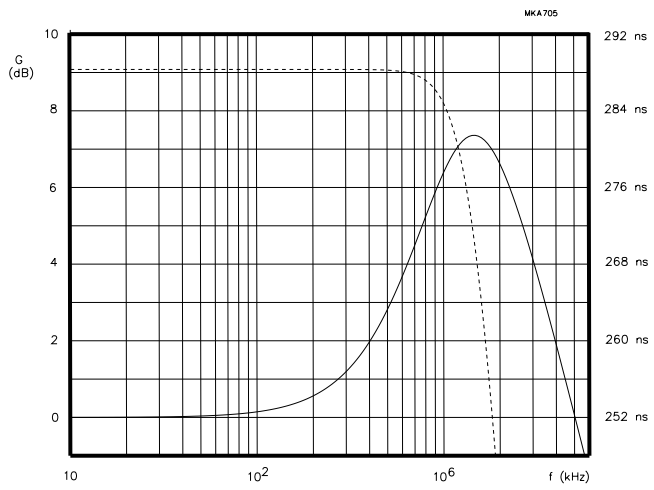
→ = test limit.

Fig.5 Output current as a function of input current.



↓ = test limit.

Fig.6 Gain as a function of V_{DD}.



The dashed line = delay (ns); the solid line = gain (dB).

Fig.7 Transfer for single speed.

INTERNAL PIN CONFIGURATION

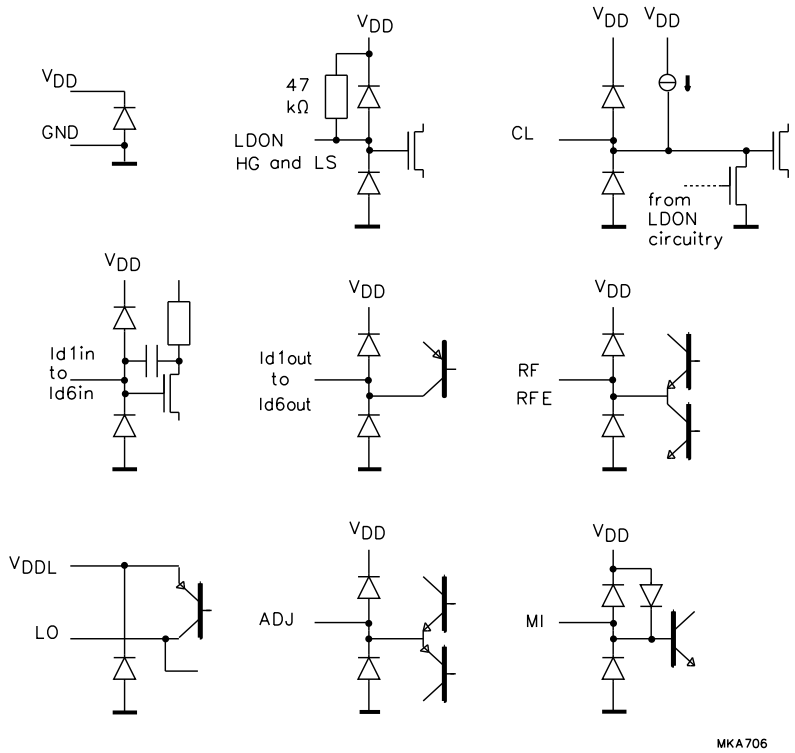


Fig.8 Equivalent internal pin diagrams.

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APPLICATION INFORMATION

The TDA 1302T is optimized for Philips CDM12 mechanisms and, subsequently, this application is preferred.

Application with Philips CDM12

The CDM12 mechanism uses an N sub-laser diode together with a P sub-monitor diode and, since TDA1302T is optimized for this type, besides the standard components CL and R_{ADJ}, no other external components are required as illustrated in Fig.9.

As two central spot diodes are summed together inside the pick-up unit, one input pin remains unused as shown in Fig.10. Unused central spot inputs should be connected to ground in order to eliminate noise contribution to the RF and RFE signals.

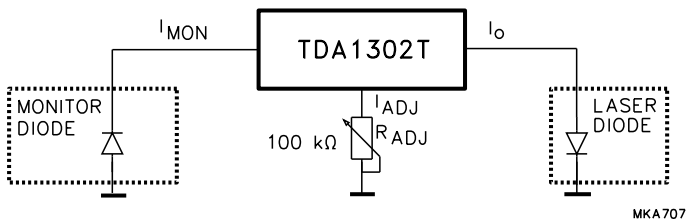

Fig.9 Application of the CDM12 laser/monitor diode unit.

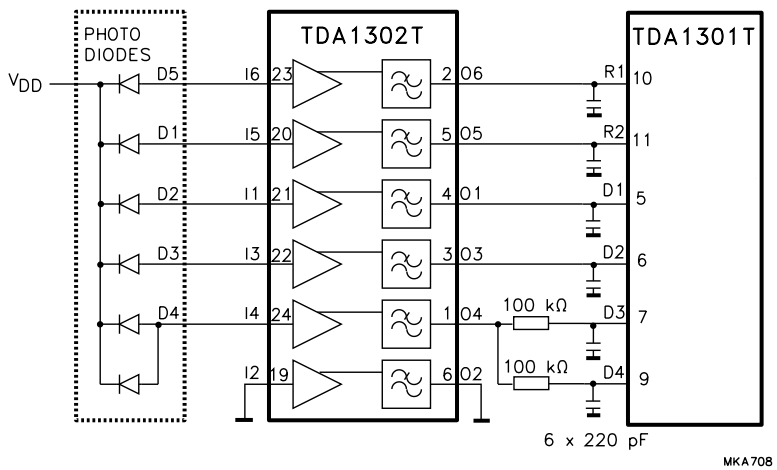

Fig.10 Application of the CDM12 pick-up unit.

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Application of other mechanisms

The TDA1302T can accommodate all laser/monitor configurations with an N sub-laser diode. When an N sub-monitor diode is used, external circuitry is required as illustrated in Figs 11(a) to 11(d). Most of these laser/monitor diode units have a variable resistor (R_m) in parallel with the monitor diode which has been pre-adjusted so that the voltage drop across this resistor has a specific value at nominal laser diode output power. The four circuits given each detail specific values for some frequently used pick-up units as given in Table 3. Each circuit has its own advantages. All circuits illustrated make use of the fixed voltage (<200 mV) across the built-in monitor resistor.

Table 3 Pick-up units.

PICK-UP UNIT	MANUFACTURER	APPLICATION
SLD104U	Sony corporation	KSM210 (Sony)
LT022MS	Sharp corporation	KSM210 (Sony)
RLD-78MA	Rohm corporation	KSM210 (Sony)
		HOP-M3TR (Hitachi)
SF91	Sony corporation	CDV90V1 (Sanyo)

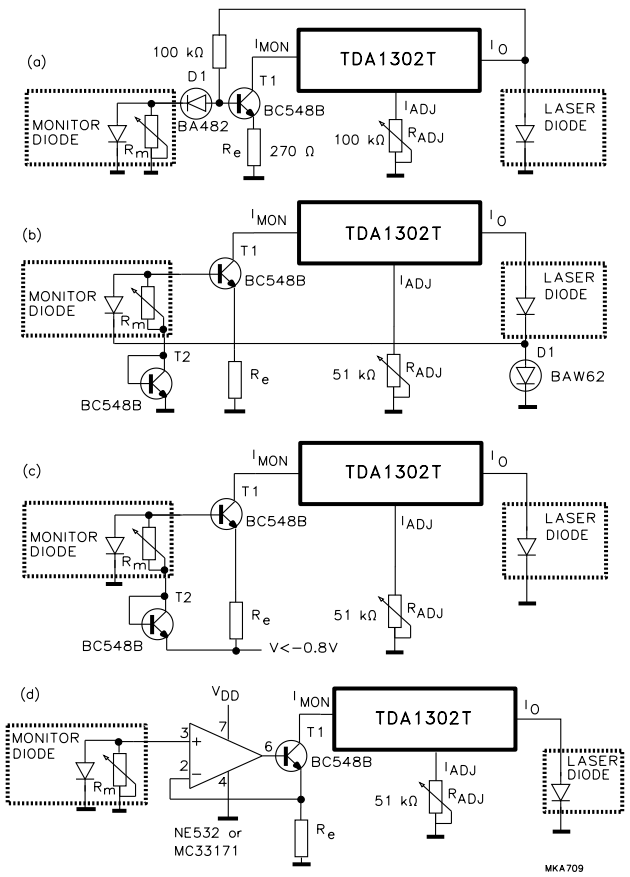

Fig.11 Applications of the laser/monitor units.

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PROPERTIES OF CIRCUIT FIG.11(a)

It is important that the V_d(D1) approaches V_{be}(T1) at approximately 150 μA, that is why a small diode has been applied such as the BA482. Additional adjustment may be necessary. this depends on the matching of V_d(D1) and V_{be}(T1) and the permitted tolerance on the laser current. The advised adjustment procedure is as follows:

1. Ensure that R_{ADJ} has the highest impedance at the beginning of the adjustment.
2. Adjust R_{ADJ} until the voltage across R_m has the value as indicated in Table 4.

Table 4 Variable resistor (R_m) voltage adjustment.

PICK-UP UNIT	MANUFACTURER	V_{Rm} (mV)
SLD104U	Sony corporation	150
LT022MS	Sharp corporation	150
RLD-78MA	Rohm corporation	150
SF90	Sanyo corporation	180
SF91	Sanyo corporation	180

Table 5 Further circuit properties of Fig.11.

FIGURE	PROPERTIES
(a)	single supply voltage
	only a few components are required; 2R, 1T and 1D
	supply voltage independent
(b)	single supply voltage
	only a few components are required; 1R, 2T and 1D
	supply voltage independent
	no extra adjustment necessary if T1 and T2 match
(c)	only a few components are required; 1R and 2T
	supply voltage independent
	no extra adjustment necessary
	better power efficiency than (b)
(d)	single supply voltage
	supply voltage independent
	no extra adjustment necessary
	no matching components required

In Figs 11(b) to 11(d) solutions have been given requiring no adjustment. R_{ADJ} and R_e can be calculated as follows: $R_{ADJ} = 12.4R_e/V_{Rm}$ at $P_{o(nom)}$.

Examples of advised values applicable to Fig.11(b), (c) and (d) are given in Table 6.

Table 6 Advised circuit values.

PICK-UP UNIT	MANUFACTURER	R_e (Ω)	R_{ADJ} (kΩ)
SLD104U	Sony corporation	620	51
LT022MS	Sharp corporation	620	51
RLD-78MA	Rohm corporation	620	51
SF90	Sanyo corporation	750	51
SF91[1]	Sanyo corporation	750	51

Note

1. Notwithstanding that the SF91 specification details an astigmatic detection system, TDA1301T requires a single Foucault parameter setting.

Figures 12 and 13 give the application diagrams of the pick-up unit of the mechanisms as previously indicated.

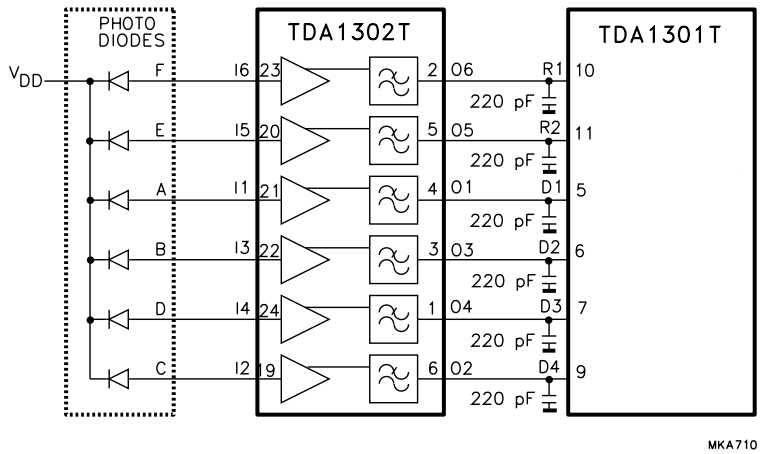

Fig.12 Application of pick-up units SLD104U, LT022MS and RLD-78MA.

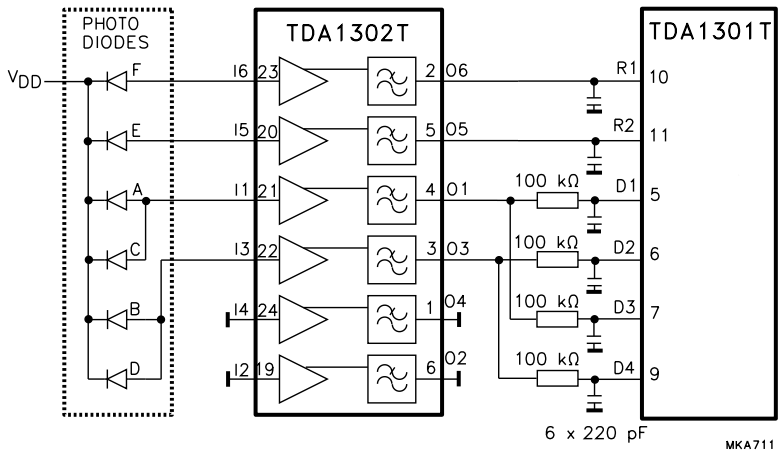

Fig.13 Application of pick-up unit SF91.

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Circuit recommendations

PRINTED-CIRCUIT BOARD LAY-OUT ITEMS

It is advised to keep the output wires of the diode current amplifiers separated from the input as much as possible to prevent oscillations.

EXTERNAL MONITOR DIODE CIRCUITRY

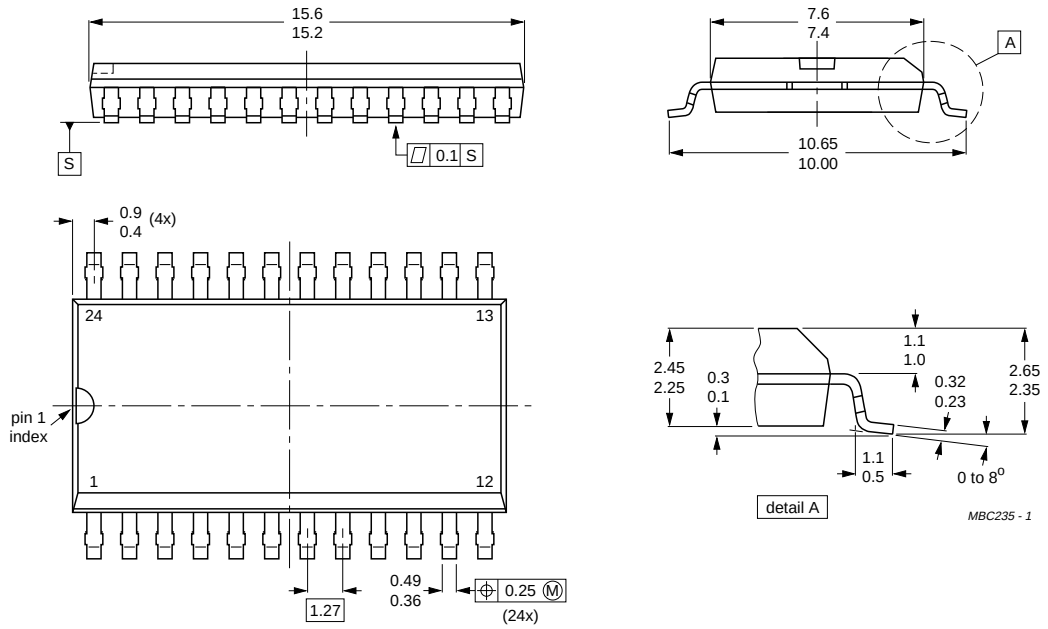
TDA1302T protects the laser diode against damage due to supply voltage transients. When any external circuitry is used in the 'laser diode-monitor diode' chain, the safety of the laser diode completely relies on the quality of this external circuitry. Therefore, it should be noted that:

1. If such a circuit requires a supply voltage, make sure that this voltage is present at least at the same moment as V_{DDL} or earlier.
2. It is advised not to implement integrating actions in this external circuitry as this may conflict with the internal integrator, especially during possible supply voltage drops.

MEASUREMENT OF THE LASER DIODE CURRENT

It is advised not to connect any current meter directly in series with the laser diode. A safe method is the inclusion of a 1 Ω resistor, connected in series with the laser diode, and measuring the voltage across this resistor.

PACKAGE OUTLINE



Dimensions in mm.

Fig.14 Plastic small outline package; 24 leads; body width 7.5 mm (SO24L; SOT137AH).

SOLDERING

Plastic small-outline packages

BY WAVE

During placement and before soldering, the component must be fixed with a droplet of adhesive. After curing the adhesive, the component can be soldered. The adhesive can be applied by screen printing, pin transfer or syringe dispensing.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder bath is 10 s, if allowed to cool to less than 150 °C within 6 s. Typical dwell time is 4 s at 250 °C.

A modified wave soldering technique is recommended using two solder waves (dual-wave), in which a turbulent wave with high upward pressure is followed by a smooth laminar wave. Using a mildly-activated flux eliminates the need for removal of corrosive residues in most applications.

BY SOLDER PASTE REFLOW

Reflow soldering requires the solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the substrate by screen printing, stencilling or pressure-syringe dispensing before device placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt, infrared, and vapour-phase reflow. Dwell times vary between 50 and 300 s according to method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 min at 45 °C.

REPAIRING SOLDERED JOINTS (BY HAND-HELD SOLDERING IRON OR PULSE-HEATED SOLDER TOOL)

Fix the component by first soldering two, diagonally opposite, end pins. Apply the heating tool to the flat part of the pin only. Contact time must be limited to 10 s at up to 300 °C. When using proper tools, all other pins can be soldered in one operation within 2 to 5 s at between 270 and 320 °C. (Pulse-heated soldering is not recommended for SO packages.)

For pulse-heated solder tool (resistance) soldering of VSO packages, solder is applied to the substrate by dipping or by an extra thick tin/lead plating before package placement.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

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